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TITLE: LITHIUM ION SECONDARY BATTERY  
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## ABSTRACT:

PROBLEM TO BE SOLVED: To enhance high rate discharge characteristics and suppress temperature rising in high rate discharge by arranging a mixture containing an active material formed on a current collector of a negative electrode or a positive electrode so as to have the density difference in the plane direction of the current collector.

SOLUTION: A negative electrode formed by arranging a negative mixture containing a negative active material such as carbon capable of absorbing/releasing lithium on a current collector and a positive electrode formed by arranging a positive mixture containing a positive active material comprising a composite oxide containing lithium such as

LiNiO<sub>2</sub> on a current collector are stacked through a separator, and they are housed in a battery container together with a nonaqueous or solid electrolyte to constitute a lithium ion secondary battery. In the lithium ion secondary battery, at least one mixture, for example a positive (negative) mixture 11 on an about 10-50 $\mu$ m thick Al(Cu) current collector 12 is distributed in a doted shape, and an electrolyte is supplied to between the dots. The mixture 11 is preferable to be arranged so as to have a thickness of 80 $\mu$ m or more, a volume ratio of 30 volume percent or more, a diameter or a maximum diagonal length of 3mm or less, and a distance of 0.5mm or more.

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て安全性も向上できたことがわかる。

【0023】上記した実施例および比較例では、正、負極合剤の厚みが9.5μm以上、体積比率が5容量%であったが、正、負極合剤の厚みが6.0～7.0μm程度以下の場合や体積比率が2.0～3.0容量%程度以下の場合には、単位面積当りの電流密度が小さくなるので、高率放電特性や温度上昇といった点での問題はないので、本発明の構成は特に大容量形のリチウムイオン二次電池の高率放電特性を改良したり、温度特性を向上させる上で有効である。

#### 【0024】

【発明の効果】以上、詳述した如く、本発明のリチウムイオン二次電池は、高率放電特性にすぐれ、高率放電時の温度上昇も抑制できるから、安全性の点においてすぐ

れ、きわめて工業的価値の高いものである。

#### 【図面の簡単な説明】

【図1】本発明の実施の形態に係るリチウムイオン二次電池の正極活性物質の分布を示す平面図(a)および断面図(b)である。

【図2】前記実施の形態に係る変形例の平面図である。  
【図3】前記実施の形態に係る変形例の平面図である。  
【図4】前記実施の形態に係る変形例の平面図である。  
【図5】前記実施の形態に係る変形例の平面図である。

#### 10 【符号の説明】

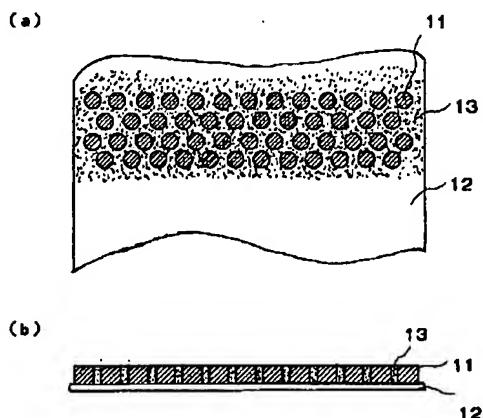
1 正極

11 正極合剤

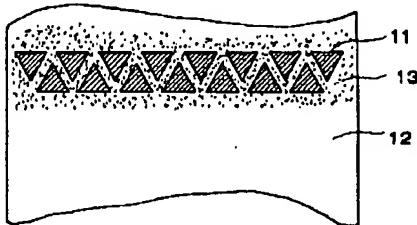
12 集電体

13 電解質

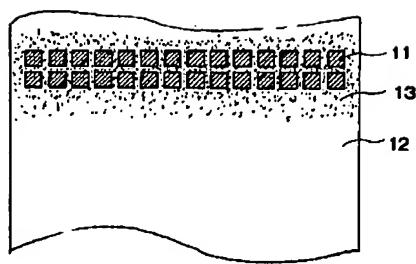
【図1】



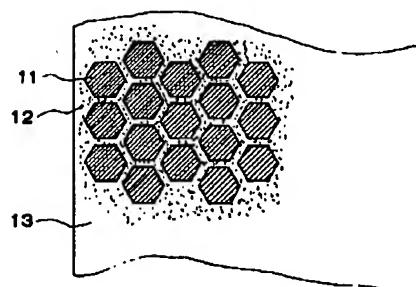
【図2】



【図3】



【図4】



【図5】



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1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

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**DETAILED DESCRIPTION**

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**[Detailed Description of the Invention]****[0001]**

[Field of the Invention] If it says in more detail about a rechargeable lithium-ion battery, this invention can improve the high-rate-discharge property, and relates to the rechargeable lithium-ion battery which can control the temperature rise at the time of high rate discharge.

**[0002]**

[Description of the Prior Art] In recent years, lightweight-izing and large capacity-ization is called for and, as for the small cell used as the power source with the miniaturization of a portable electronic device, and multi-functionalization, the large-sized cell by which the large capacity for electric vehicles etc. is demanded is also asked for lightweight-izing and reinforcement. the negative electrode with which a rechargeable lithium-ion battery contains occlusion and the negative-electrode active material which can be emitted for a lithium -- since the mixture is used and there is no problem of producing an internal short circuit by the dendrite which deposits on a negative electrode at the time of charge in a negative-electrode active material like the rechargeable battery using the alloy which makes a lithium and a lithium a subject, it is observed from every direction.

[0003] the negative electrode which contains occlusion and the negative-electrode active material which can be emitted for the above-mentioned lithium -- that to which the rechargeable lithium-ion battery using a mixture used nonaqueous electrolyte for the electrolyte is already put in practical use, and research in fields, such as amelioration of the high-rate-discharge property and control of the temperature rise at the time of high rate discharge, is made.

[0004] The typical thing of said rechargeable lithium-ion battery A positive electrode is the cobalt acid lithium LiCoO<sub>2</sub> as positive active material to the front face of the aluminium foil as a charge collector. It consists of what was applied by uniform thickness. A negative electrode consists of what applied particles, such as carbon as a negative-electrode active material, to the front face of the copper foil as a charge collector by uniform thickness, such a positive electrode and a negative electrode pile up through a separator, it is involved in spirally or there are some which two or more sheet laminating was carried out to plate-like, and were held in the battery case.

**[0005]**

[Problem(s) to be Solved by the Invention] The above-mentioned rechargeable lithium-ion battery had the problem that generated heat all over a positive electrode and a negative electrode, and a temperature rise increased at the time of high rate discharge since the problem that discharge capacity falls when a current concentrates on the edge section of the problem that discharge capacity falls when diffusion of a lithium ion does not fulfill demand within positive active material and a negative-electrode active material, a positive electrode, and a negative electrode, positive active material, and a negative-electrode active material are uniform thickness.

**[0006]**

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, invention according to claim 1 In the rechargeable lithium-ion battery which consists of a positive electrode which

consists of a mixture, and an electrolyte the negative electrode containing lithium occlusion and the negative-electrode active material which can be emitted -- the negative electrode which consists of a mixture, and the positive electrode containing the positive active material which consists of a multiple oxide containing a lithium -- It is characterized by having established the difference of a consistency and arranging one [ at least ] mixture to the direction of a flat surface of a charge collector, and thereby, a lithium ion can be easily diffused in the part of a low consistency, and the edge section of the part of high density can be made to distribute a current.

[0007] Moreover, in a rechargeable lithium-ion battery according to claim 1, it is characterized by distributing one [ at least ] mixture of a negative electrode or a positive electrode in the shape of a dot, the gap of the mixture distributed in the shape of a dot is filled up with an electrolyte like nonaqueous electrolyte or a solid electrolyte by this, and invention according to claim 2 can diffuse a lithium ion easily in this gap.

[0008] Moreover, thickness can be characterized by 80 micrometers or more and the rate of a volume ratio being more than 30 capacity %s, and the mixture over which invention according to claim 3 was distributed in the shape of a dot in the rechargeable lithium-ion battery according to claim 1 or 2 can do by this \*\* which diffuses the lithium ion in the part of a low consistency efficiently, and can distribute effectively the current to the edge section in the part of high density.

[0009] Moreover, a diameter or the maximum diagonal line length can be characterized by 3mm or less and spacing being 0.5mm or more, and the mixture over which invention according to claim 4 was distributed in the shape of a dot in the rechargeable lithium-ion battery according to claim 1 or 2 can do by this \*\* which diffuses the lithium ion in the part of a low consistency efficiently, and can distribute effectively the current to the edge section in the part of high density.

[0010]

[Embodiment of the Invention] Hereafter, this invention is explained based on the gestalt of the operation.

[0011] the top view (a) of the positive electrode 1 used for the rechargeable lithium-ion battery which drawing 1 requires for the gestalt of operation of this invention, and a sectional view (b) -- it is -- 11 -- nickel acid lithium LiNiO<sub>2</sub> the positive electrode included as positive active material -- a mixture and 12 are charge collectors which consist of aluminium foil. said positive electrode 1 -- said charge collector 12 top -- a positive electrode -- a mixture 11 is arranged in the shape of [ circular ] a dot, and constitutes -- having -- a dot-like positive electrode -- while setting the diameter of a mixture 11 to 3mm or less and making spacing set to 0.5mm or more, thickness is set to 80 micrometers or more, and the rate of a volume ratio is carried out to more than 30 capacity %. Moreover, said charge collector 12 is setting thickness to 10-50 micrometers.

[0012] The gap of a mixture 11 can be filled up with an electrolyte 13 like nonaqueous electrolyte or a solid electrolyte. above -- a positive electrode -- the positive electrode distributed in the shape of a dot by arranging a mixture 11 -- While being able to promote diffusion of the lithium ion in this part and being able to improve a high-rate-discharge property the current at the time of high rate discharge -- a dot-like positive electrode -- each edge of a mixture 11 can be distributed, it is eased by the heat dissipation between which it is placed [ make ] by the convection current and solid electrolyte of said nonaqueous electrolyte, and generation of heat accompanying it can control a temperature rise.

[0013] the above-mentioned gestalt of operation -- a positive electrode, although the mixture 11 is arranged in the shape of [ circular ] a dot what restricts the configuration circularly -- it is not -- a dot-like positive electrode, while setting the maximum diagonal line length of a mixture 11 to 3mm or less and making spacing set to 0.5mm or more Thickness is set to 80 micrometers or more, and it cannot be overemphasized that you may be polygons, such as more than 30 capacity % then a triangle like drawing 2 , a square like drawing 3 , and a hexagon like drawing 4 , about the rate of a volume ratio.

[0014] moreover, the positive electrode distributed in the shape of a dot with the above-mentioned gestalt of operation, although the gap of a mixture 11 is made into space while setting the dot-like the diameter or the maximum diagonal line length of an active material to 3mm or less and making spacing set to 0.5mm or more -- thickness -- 80 micrometers or more -- carrying out -- the rate of a volume ratio

-- the positive electrode of more than 30 capacity %, then the shape of an another dot of different thickness like drawing 5 -- a mixture -- 11' can also be prepared.

[0015] the negative electrode with which a carbon particle is included as a negative-electrode active material in the case of the negative electrode which similarly is used for the rechargeable lithium-ion battery concerning the gestalt of operation of this invention -- the shape of a dot circular on the charge collector which consists a mixture of copper foil -- arranging -- a dot-like negative electrode -- while setting the diameter of a mixture to 3mm or less and making spacing set to 0.5mm or more, thickness is set to 80 micrometers or more, and the rate of a volume ratio is carried out to more than 30 capacity %. Moreover, said charge collector is setting thickness to 10-50 micrometers.

[0016] The separator which consists of a micropore film made from polyethylene the positive electrode produced as mentioned above and a negative electrode is made to intervene, a laminating is carried out, and it considers as the winding object involved in spirally or the layered product which carried out two or more sheet laminating, and with nonaqueous electrolyte, it contains in a battery case and considers as the rechargeable lithium-ion battery of this invention. In addition, it may replace with said nonaqueous electrolyte and separator, and a solid electrolyte may be used. Moreover, as for said positive electrode or negative electrode, at least one side may be produced as mentioned above.

[0017]

[Example] Hereafter, this invention is explained based on an example.

[0018] (Example 1) Nickel acid lithium LiNiO<sub>2</sub> as positive active material The mixed powder 74 weight section which the acetylene black powder as 90 weight sections and an electric conduction agent becomes [ powder ] from 10 weight sections, Solute LiPF<sub>6</sub> as nonaqueous electrolyte Mixed solvent ethylene carbonate, The thing 22 weight section dissolved in diethyl carbonate and dimethyl carbonate, Circular the epoxy acrylate resin 4 weight section as binding material -- kneading -- a positive electrode -- a mixture -- a diameter is about 2.5mm on the aluminium foil as a charge collector whose thickness it considers as a paste and is 20 micrometers about this -- It prints so that it may be distributed in the shape of a dot at intervals of about 0.5mm, and ultraviolet rays are irradiated, are stiffened, and it considers as a positive electrode. in this way, the obtained positive electrode -- the thickness of a mixture was 120 micrometers and the rate of a volume ratio was 50 capacity %. the nonaqueous electrolyte as 65 weight sections and said presentation with the carbon powder same on the other hand as a negative-electrode active material -- 30 weight sections and said binding material resin -- 5 weight sections -- kneading -- a negative electrode -- a mixture -- it considers as a paste, and this is printed like a positive electrode on the copper foil as a charge collector whose thickness is 10 micrometers, ultraviolet rays are irradiated, are stiffened, and it considers as a negative electrode. the negative electrode of this negative electrode -- a mixture -- the positive electrode of a positive electrode -- it was distributed in the shape of a dot like the mixture, and thickness was 110 micrometers and the rate of a volume ratio was 55 capacity %. Next, after having contained to the metal battery case after made the microporous polyethylene film whose thickness as a separator is 25 micrometers about the 40mmx30mm thing of said positive electrode and a negative electrode intervene, having carried out the laminating, having considered as the unit cell, connecting this unit cell to two or more sheet superposition and connecting each unit cell to juxtaposition, and pouring in nonaqueous electrolyte, it obturated and the cell of 1000mAh(s) was produced.

[0019] (Example 2) the negative electrode distributed in the shape of a dot -- the same cell as an example 1 was produced except having set thickness of a mixture to 95 micrometers.

[0020] (Example 1 of a comparison) a positive electrode -- the thickness of a mixture -- 105 micrometers of homogeneity -- carrying out -- a negative electrode -- the same cell as an example 1 was produced except having set thickness of a mixture to 95 micrometers of homogeneity.

[0021] (Example 2 of a comparison) forward and a negative electrode -- a diameter -- 5mm -- being circular -- carrying out -- spacing -- about 0.3mm -- carrying out -- a positive electrode -- the thickness of a mixture -- 110 micrometers -- carrying out -- a negative electrode -- the same cell as an example 1 was produced except having made it distributed in the shape of a dot, having used thickness of a mixture as 105 micrometers.

[0022] After a charge termination electrical potential difference charges the cell of the above-mentioned example and the example of a comparison to 4.2V by the charging current of 0.2C under a room temperature, If discharge capacity in the discharge current of 0.2C under a room temperature is made into 100% in a high-rate-discharge trial when the high-rate-discharge trial and short-circuit test which are made to discharge to discharge final voltage 2.7 by the discharge current of 2C are presented The thing of an example 1 the thing of the example 1 of a comparison 86% for the thing of an example 2 88% 67%, The thing of the example 2 of a comparison was 74%, in the short-circuit test, to abnormalities not having been accepted for the thing of an example 1 and an example 2, the thing of the example 1 of a comparison exploded and it was checked that the relief valve opened the thing of the example 2 of a comparison, and the steam of the electrolytic solution had blown off.

[0022] This shows that the rechargeable lithium-ion battery concerning this invention could be excellent in the high-rate-discharge property, it could control the temperature rise also when an excessive current like [ at the time of a short circuit ] flowed, and safety has also improved by it.

[0023] the above-mentioned example and the above-mentioned example of a comparison -- forward and a negative electrode, although the thickness of a mixture was 95 micrometers or more and the rate of a volume ratio was 55 capacity % forward and a negative electrode, when the case where the thickness of a mixture is about 60-70 micrometers or less, and the rate of a volume ratio are below 20 - 30 capacity % extent Since the current density per unit area becomes small and there is no problem in a high-rate-discharge property or the point of a temperature rise, especially the configuration of this invention is effective, when improving the high-rate-discharge property of the rechargeable lithium-ion battery of a mass form or raising the temperature characteristic.

[0024]

[Effect of the Invention] As mentioned above, as explained in full detail, since the rechargeable lithium-ion battery of this invention is excellent in a high-rate-discharge property and can also control the temperature rise at the time of high rate discharge, it is excellent in the point of safety and industrial value is very high [ a rechargeable lithium-ion battery ].

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[Translation done.]